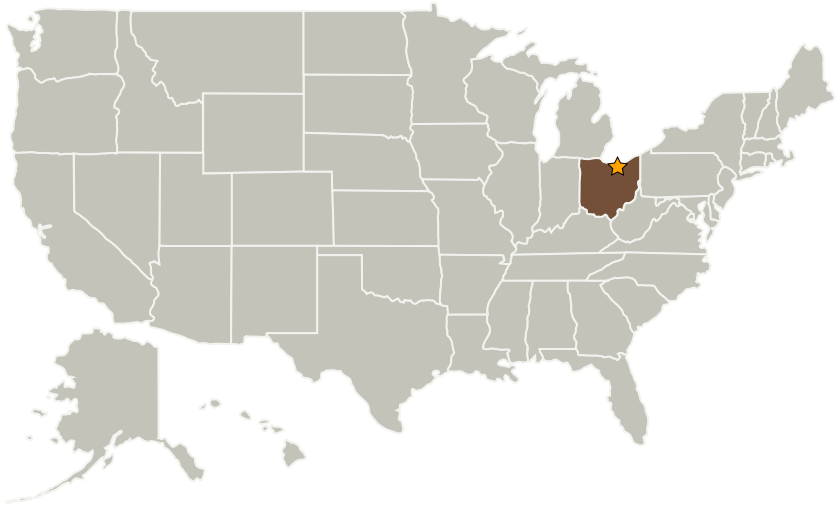
Plasma Control of Turbine Secondary Flows, Phase I

Completed Technology Project (2009 - 2009)

Project Introduction

We propose Phase I and II efforts that will focus on turbomachinery flow control. Specifically, the present work will investigate active control in a high speed turbine flow. The flow control actuators will be Single Dielectric Barrier Discharge (SDBD), or "plasma actuators." The work will be primarily experimental, with a focus on realistic operating environments for investigating the efficacy of the actuators. The proposed measurements will be the first to utilize plasma flow control in an aerodynamically realistic LPT environment. The objective of the research will be to study the secondary flows in a modern low pressure turbine (LPT) environment, and use active flow control to provide enhanced aerodynamic and/or heat transfer characteristics by controlling the secondary flows through the nozzle and rotor sections of the turbine. The research will build upon extensive experimental development and numerical modeling of weakly-ionized plasma actuators for flow control applications. The study of these actuators in realistic operating environments will be made possible using a new transonic turbine rig located at the University of Notre Dame. The objectives of the proposed research will involve measurements of the baseline flow field, including the secondary flows produced by the inlet nozzle vanes and the rotor vanes. These data will be used to motivate the actuator design for reduced secondary flows and losses. Specifically, a conceptual model will be constructed to describe how vorticity from the endwall boundary layers, blade surface, and tip gap is stretched and convected into regions of high loss. The actuators will be used to modify the unsteady surface vorticity flux through the plasma body force in order to reduce the net secondary flow losses.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Spectral Energies, LLC	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Dayton, Ohio

Primary U.S. Work Locations
Ohio

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.5 Propulsion Flowpath and Interactions